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3/4/64

MAR 4 1964

Statement of
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before the

Senate Committee on Aeronautical and Space Sciences

Mr. Chairman and Members of the Committee.

It is a privilege to be here today to present President Johnson's recommendations for the authorization of funds for the program of the National Aeronautics and Space Administration for Fiscal Year 1965. Dr. Dryden, Dr. Seamans, and I will endeavor to deal as fully as possible with those basic questions of national space policy which we believe to be of greatest interest to the committee.

In my remarks, I will attempt to provide a general overview of the program as a whole, with particular attention to some specifics in which the committee, or some of the members, have expressed interest. Dr. Seamans, as Associate Administrator and General Manager, will deal with the management aspects of the Agency, and its relationships with the industrial organizations which perform, under contract, some 90 per cent of our work. Dr. Dryden, who has so ably represented this government in its negotiations on space matters with the Soviet Union, will review the progress which has been made, and discuss, as well, other international aspects of the programs of the National Aeronautics and Space Administration.

It is apparent to most persons who are concerned with the national space effort that we have reached what you described recently, Mr. Chairman, as a "critical midpoint" in our effort to achieve space pre-eminence for the United States. We have moved from a circumstance in which the Soviet Union held clear superiority in space to one in which, as a result of the driving effort put forth in the past five years, we have achieved a degree of parity with the Russians in our ability to penetrate and operate in the space environment.

As a consequence of this significant progress, the nation is in a position to consider not merely what it is <u>able</u> to do in space, but also what it is <u>wise</u> to do in view of our greatly increased scientific and technical ability. We have, in short, moved from a period in which we did everything we could in space, and regretted our inability to do more, to one in which we have a very large capability and are increasingly confronted with hard decisions in the selection of the programs which we will undertake.

This is the position in which NASA found itself in preparing the program which is the basis for the FY 1965 authorization request. We have deferred or eliminated many projects which were worthy contenders for a place in the program and which, I believe, when budgetary limitations are less restrictive, the nation will decide to undertake. The activities which are proposed for FY 1965 will, in my judgment and that of my associates, produce the greatest benefits for the country within the limitations of the national resources which the President has decided are available and can prudently be spent for NASA programs.

It is essential to recognize, in considering the investment which the nation has made in space research and development, and that which is proposed in the authorization request for Fiscal Year 1965, that a substantial outlay has already been made to equip the nation for space research and exploration. Occasionally, one hears concern expressed over the substantial portion of NASA funds expended for testing and launching complexes, and for "hardware," as differentiated from the actual costs of basic scientific research. Actually, such requirements are inherent in the mid-twentieth century changing character of scientific research, whether it be research aimed at greater understanding of the most elementary particles of matter, or research conducted in the vast reaches of space--unquestionably the greatest laboratory ever opened to mankind. They are necessary to the basic structure of engineering and technical competence which must underlie a national ability to move rapidly toward a national defense utilization of space, when and if required. In space research, the ground facilities, rockets and spacecraft which enable the scientist to do work in space are also extremely expensive, although they are what may be called the test tubes and bunsen burners of the space age.

Much of our investment during the first five years of national space effort has gone into items which are, in reality, laboratory equipment. Fortunately, however, most of this investment has not been in limited or one-time use hardware, but rather in a substantial structure of basic resources which will be available to meet both military needs and civilian needs in the years ahead. In addition to the building of very large boosters and spacecraft for experimental manned operations, we have developed the operational systems which are required for their effective use, and have made the capital investment required for the large engineering complexes for their assembly, test, and launching. We have developed and are installing the large environmental chambers, centrifuges, and simulators for astronaut preparation and training, as well as a world-wide tracking and data acquisition network feeding into an integrated mission control center through which a number of flights can be controlled simultaneously.

Meanwhile, we have acquired operational experience which is teaching us how to use space, not only with instrumented spacecraft, but with manned craft as well. This experience included some 55 hours of manned flight in the Mercury program, and will encompass 4500 to 5000 man hours of space flight in the Gemini and Apollo programs before the first astronauts depart for the moon.

Some of our most stubborn problems and some of our greatest successes are related to the fact that it has been necessary to develop entirely new means of organizing large scale research and development efforts devoted to the same areas which have provided our industrial strength in times past and which, now more than ever, underlie future economic growth for this nation--the use of energy in both large and small amounts under close control; advanced electronics, guidance, and control systems; the use of the most advanced new materials, fabrics, lubricants, etc.; the integration of research in the physical sciences with that in the life sciences; and the organization of the entire effort through systems management concepts based on knowledge gained from previous large programs such as the Minuteman, Polaris and other ballistic missile programs.

The success of much of this work depends on highly imaginative scientific research in the physical sciences such as physics and chemistry, in mathematics, in biology, and on the rapid translation of this knowledge into utilization in advanced technological applications and engineering. Large parts of this work, both scientific and technical, cut across the lines of many disciplines. In a growing number of cases, success seems best assured when appropriate parts of it are carried out in university laboratories in connection with graduate education, or by industry working in close association with broad university multidisciplinary participation.

These, then are the specific resourches which are being developed. But not to be overlooked are many other factors which will undergird United States space power and position in the technological balance of power in the years ahead.

These include the framework of policy and action to carry out this effort, such as the building and proper utilization of stronger scientific research capabilities and facilities in the nation's universities, the widespread very advanced industrial capability which is being developed, the widest possible utilization of those technological developments which can improve either the capability or the efficiency of industry, and the governmental framework required to manage this greatest and most challenging enterprise in this history of mankind.

Although great emphasis has been placed during these years on "gearing up" to ensure enduring pre-eminence for our nation in space, the period has not been without specific accomplishment. It can fairly be said today that, after five years of driving effort, with much of the support and impetus stemming for the committee and from the Congress, we have moved from a period of preparation toward a period of fruition. We are still deeply concerned, of course, with developing the technology, building the facilities, acquiring the scientific knowledge, and gaining the operational experience, which will give us real capability and flexibility in space. But we are also at the point when all of this effort, and this investment, are beginning to produce tangible results. Much of the foundation has been laid. The portents of space exploration and utilization as a boon to our nation and to mankind are beginning to become apparent.

At what you have called "this midpoint" in our space program, Mr. Chairman, it may be of value in assessing our future course to review briefly some of the achievements which have resulted from the basic resources for space research and exploration which we have developed.

More than two-thirds of the two hundred satellites and interplanetary probes launched into space have been the product of U.S. scientists and engineers. These instrumented vehicles are exploring interplanetary space, a region rich in energy, radiation, and fast-moving particles of great variety. As you know, the scientists' desire to learn more about this interplanetary medium stems from the knowledge that almost all phenomena on earth, including life itself, are dependent upon energy from the sun which streams toward the earth through 93 million miles of space.

The scientific data collected by these space vehicles is greatly extending many of the natural sciences, bringing answers to questions which have perplexed mankind from the earliest days of human existence on earth. The first United States satellite confirmed the existence of the great radiation belt which surrounds the earth and the characteristics of this belt have been further defined by many subsequent vehicles. Another early satellite discovered that the earth, rather than being an oblate spheroid as had been supposed, is actually slightly flattened at the poles. Subsequently, it was also discovered that a slight bulge exists at the equator giving the earth a pear shape. Not only did these discoveries have great scientific significance, but they are of extreme importance to the military in plotting flights and targets, to the cartographers, and in space navigation.

The Pioneer V spacecraft, launched in March 1960, into an orbit between the earth and Venus, transmitted data from a then record distance of 22.5 million miles from the earth. It confirmed the existence of an interplanetary magnetic field and showed that the field varied with solar flare activity and the field's interaction with a stream of charged particles which is known as the solar wind.

Satellite observations of the ionosphere, not only by this country's scientists but by those of Canada and Great Britain, have illuminated or explained many of the mysteries regarding this great band of thin ionized gases at the top of the atmosphere, which profoundly affects radio transmission. This knowledge has led to a project which involves the mapping of the ionosphere through at least one complete 11-year solar cycle to gain knowledge of value not only for civilian and scientific purposes but to the military agencies, as well.

Satellites have also detected the presence of a layer of helium which surrounds the earth in a band nearly 1,000 miles deep beginning at an altitude of about 600 miles and the possibility of a huge ring of hydrogen extending out to some 6,000 miles. Within this area of concentration of cosmic dust has been discovered which scientists believe may be related to periods of heavy rainfall on earth.

Other space phenomena detected by satellite observations include measurements of the solar wind, of solar flares, of micrometeorite and numerous other observations. Some of the information returned, particularly that gathered in intergalactic space, gives promise of answering fundamental questions about the origin and development of the universe, and providing a basis from which to predict the future.

Other satellites and ground-based observations have established that radiation and other hazards in space do not constitute the threat to America's astronauts that had once been feared. Studies of the largest solar flares recorded since July 1959, indicate that the maximum dosages of radiation in the command module of the Apollo spacecraft and in the Apollo space suit, would, during such flares, have been below the limits which the Space Science Board of the National Academy of Sciences found acceptable in their report of July 1962. Moreover, Explorer XVI findings, coupled with ground observations, also indicate that meteoroids will not constitute a major problem. Thus, we are confident that our astronauts can travel safely to the moon in this decade, without undue risk from conditions encountered in space.

Perhaps the most exciting and profitable scientific venture in space to date was the flight of Mariner II in late 1962. This remarkable spacecraft transmitted more than 65 million bits of information to earth, operating at a record distance of nearly 54 million miles from the earth. En route to Venus it affirmed the concentration of cosmic dust near the earth, and found that the amount of radiation encountered was significantly less than had been anticipated. It registered an 800 degree surface temperature on Venus--too high to sustain life as we know it--detected no water vapor and no cosmic dust. It also determined that the planet has no apparent rotation or magnetic field.

While obtaining these scientific results, we have also moved forward in developing the advanced technology which will support the more elaborate space missions which may be required in the future--missions which will further extend the ability of our scientists to probe the secrets locked in the solar system and use the knowledge gained.

One of the most interesting areas is that of propulsion. For example, we have demonstrated the value of fluorine to enrich the oxidizer and advance the performance of our rocket engines. The FY 1965 program includes plans for the experimental conversion of an existing hydrogen-oxygen engine to use fluorine as the oxidizer, increasing performance about five per cent and nearly doubling the bulk density of the propellant.

Another promising development in the propellant field is a catalyst that will decompose hydrazine on contact and without the addition of heat. This catalyst promises to provide a performance increase of nearly 50 per cent over existing mono-propellant auxiliary propulsion system performance values. Moreover, it would give us, in effect, an energy source that can be tapped simply by operating a valve.

Advances are also being made in the booster engines themselves. Our engineers have learned, for example, that performance gains can be realized by the use of altitude compensating nozzles, and to realize these gains they are studying the clustering of several conventional engine chambers to exhaust into a single nozzle.

Another concept, for use still farther in the future, is a method of simplifying the combustor while retaining the performance advantages of the compensating nozzle. One method under study is a system in which the combustion chamber has the shape of a toroid. The chamber exhaust gases go through ports between the tubes of the chamber and are thus expanded in a single nozzle in the same manner as with the multiple chamber engine concept which I have already mentioned. If this toroidal chamber can be perfected it has the prospect of being adaptable to any future thrust requirement.

These are but a few of the scientific results and technical advances obtained in the first years of the nation's effort in space. The early years of the space program have brought tangible results in more practical areas, as well. You are all familiar with the work of the applications satellites in communications and meteorology. The Telstar and Relay vehicles have demonstrated the feasibility of satellite communications of all sorts, including the transmission of television broadcasts on a worldwide basis. The Syncom satellite, placed in a nearly stationary orbit in what was the most complex demonstration of guidance yet achieved, proved the feasibility of a satellite communications system which could virtually cover the globe with only three spacecraft in orbit.

The Tiros meteorological satellites have been so successful that their value is well known throughout the world, and weathermen everywhere have become accustomed to rely on data from their operations. The Weather Bureau is now moving toward operational use of these satellites, and a new Automatic Picture Transmission system has been devised which will permit any nation or unit of our armed forces to obtain photographs of the cloud cover over its own area as the satellite passes overhead.

But, Mr. Chairman, these practical applications and scientific results are only part of the story. To fully appreciate the value of the space program to the nation, one must consider the residual value in the experienced and trained labor force stemming from this great industrial effort; the increased value of our educational plant and organization, including both faculty and graduate students, resulting from the extensive research and training conducted for NASA in the universities; the value of such operating systems as communications and weather satellites; and the value to our military services and to national security in the basic structure which is the image we now have of a "can do" nation, one that creates its prestige among the nations by demonstrating, openly, on the television screens of all the world, its capacity to take measurements of Venus, or launch the largest weight ever put in orbit by man, or link the peoples of the world with Telstar, Relay and Syncom, or launch and recover six astronauts, or provide all nations with satellite weather data from our spacecraft as they pass overhead.

With this review in mind, Mr. Chairman, let me turn now to the authorization request for FY 1965. With your permission, because it is essential to intelligent evaluation of the request for 1965, I will also include some reference to President Johnson's request for a supplemental appropriation for FY 1964.

During my testimony last year, when the FY 1964 authorization was before the committee, I indicated that the amount requested by President Kennedy was required to maintain a balanced effort in space, and the momentum needed to insure that the national goal of lunar exploration would be achieved within this decade. I testified further that unless the requested funds were authorized and appropriated, our target dates could not be maintained as realistic goals and it would be impossible to complete, with some margin for error, the various phases of the Gemini and Apollo programs in time to provide the tests and data needed for the crucial decisions as to the later phases of the program.

As you know, $5,350 million was authorized for Fiscal Year 1964, a reduction of $362 million in the amount requested by President Kennedy, and only $5.1 was actually appropriated, some $600 million less than the original request. As a consequence, we have found it necessary to curtail and realign our activities in every program area, to sacrifice the remaining "insurance" or margin for error which had been built into the program as a hedge against unforeseeable or intractable technical problems, and to accept later target dates for the crucial experimental flights in both Gemini and Apollo.

I do not suggest that these delays result entirely from Congressional action on our funds for FY 1964. From the outset, in planning a program which would give the United States pre-eminence in space, it was foreseen that accurate forecasting and cost estimating for a specific segment or fiscal year would be a difficult business, at best. The nation was dealing with a new medium--space--in which there was no past experience to serve as a guide, and one which required new technology as yet undeveloped and scientific knowledge yet to be gained. Just as in long-range economic forecasting, our overall estimates of both completion dates and costs have proven much more accurate than those for the individual segments of the program. Prudent planning required that the early program be designed with considerable redundancy, and with a substantial degree of flexibility with respect to target dates. We have more accurate information now.

Over-all, even with the reductions in funds and set-back in time which we have had to absorb, we are still able to set the important target dates within a range which we believe can be met, which can give us a "fighting chance" to complete the 2000 hours of manned space flight experience which we need, and then proceed immediately to the lunar exploration, and do it in this decade. We hope Congress will give us this "fighting chance." At the levels requested by President Johnson, we can, and the costs will be substantially less than if there are further stretch-outs.

In the tight budget situation faced by the President for Fiscal Year 1965 it was necessary to stress with him and the Bureau of the Budget that unless the full $5.3 million authorization requested for FY 1965, <u>and</u> the supplemental appropriation of $141 million requested for FY 1964 are approved, the manned space flight program will encounter further delays. It will then not be possible to achieve the national goal of exploring the moon with men within this decade.

There may be some inclination to assume that the adjustment of our program to the reductions imposed for FY 1964 indicates that this will likewise be possible in the event of reductions in the request which is before you at this time. I cannot emphasize too strongly that this is not the case.

In adjusting our program to compensate for the reductions made in the appropriation for FY 1964, we have already sacrificed the margins and early target dates which were needed, and which in reality are still needed, in our effort to achieve the goals which have been set for us. In fact, Mr. Chairman, we are not able to maintain a reasonably balanced program, and accommodate the entire reduction, with any strong assurance that we can explore the moon before 1970. The best we can say is that we have a "fighting chance."

To sum up our situation in a sentence, <u>if we do not receive the funds which the President has requested, there is nothing left to sacrifice except the national goal itself</u>.

I have placed a great deal of emphasis, in these remarks, upon this national goal of lunar exploration in this decade, because that is the objective which President Kennedy, with the approval of the Congress, set before this agency, and which we have been striving to achieve. I will not, however, urge your support for this authorization request, or for the supplemental appropriation, simply because the funds are necessary if the nation is to do what it has told the world it would do. I am well aware that there are those who ask, "What is magic about the present target date?", or, "What will be lost if the lunar landing slips into the next decade?"

It is not possible to assert here today that we must reach the moon before 1970 in order to beat the Russians there. I do not know, nor can anyone in this room know, what the Soviets can or will do. Neither, however, and for the same reason, can I say that it is not necessary to do so, if Americans are to be the first to explore our nearest neighbor in space and to achieve the world leadership in space that the Russians captured in 1957.

What can be said, however, is that this decade was selected, after careful study, because it appeared to be the period in which we could reach the moon with reasonable assurance that we would be first, and in the process could develop the scientific knowledge, technical knowledge, industrial base, engineering and launch installations, and worldwide tracking and control networks. There has developed no later evidence to indicate that this decision, recommended by President Kennedy and approved by the Congress, was unsound.

It is also important, Mr. Chairman, in any consideration of the Apollo program, to resist the inclination to consider it in isolation from the overall national effort to achieve pre-eminence in space. The requirements for a successful lunar exploration are essentially the same as the requirements for overall pre-eminence, and most of the things which are included in the NASA program would be required to insure United States space leadership, even if we had no desire nor intention to place a team of American explorers on the moon.

It is also essential that we recognize that the nation did, in 1961, with overwhelming approval in the Congress, and public support, decide to attempt to place American astronauts on the moon in this decade, and return them safely to Earth. As a consequence, we have underway a program to accomplish this objective, with all of the major elements already under contract, and phased to make possible, barring some unforseen difficulties, a lunar exploration in 1969.

The nation is in a position, therefore, of already having in being a program which will accomplish this objective, and which cannot be altered without increasing the ultimate costs. Obviously, we do not know when or whether the Russians will attempt again to sieze a strong initiative in space, but whether it is agreed or not that international considerations and national security factors require that we hold to the present space program, the fact is that prudence and economy will be served.

Even if economy alone were to be the guiding consideration in the evaluation of the NASA request for FY 1965, the cost of establishing and maintaining superiority in space will be less if we maintain the pace, the momentum, which the supplemental appropriation and this authorization request will provide. And in maintaining that momentum, we will demonstrate that we have the will to carry out programs which are in our own interest, no matter what others may do, and that we intent to lead in this important new laboratory--space.

You will recall that at the time the Congress was considering President Kennedy's recommendation that we drive toward a lunar landing before 1970, NASA officials reported to you that the cost would probably run from $20 to $40 billion. Despite the difficulties which have been experienced, we can still put two American explorers on the moon in this decade, and we can do it within the lower of those two figures--for less than $20 billion.

But, Mr. Chairman, I am prepared to say that, if the program is further curtailed, if the momentum is lost, if the Apollo program is stretched into the next decade, the cost will not be under $20 billion; <u>it will be several billions more</u>. The ultimate cost will increase for each year in which achievement of our goal is delayed.

The Office of Manned Space Flight has made a careful study of the effects of a stretched-out lunar program, and prepared cost estimates involving the extension of the landing date for a period of up to six years. Dr. Mueller will go into this in more detail, but I would like to summarize the results.

This study indicates that the cost of the lunar exploration would increase by approximately $1 billion for each year that the landing is delayed. A three year delay would cost $3 billion; a six year delay, $6 billion, with no corresponding improvement in the benefits obtained.

This increased expense arises because the cost of a major research and development program is roughly the sum of three factors: (1) a constant factor that designates work that must be done and facilities that must be constructed, regardless of the pace at which the program is conducted, and with most of this going to pay the people in contractor plants working on the program; (2) an operating burden, which covers costs that must be incurred at a relatively fixed level while the program is underway, and therefore accumulate in almost direct proportion to the time required for completion of the program; and (3) a time-saving factor, which includes funds expended for such pruposes as overtime, parallel paths of development, the purchase of hardware and facilities beyond those which would be required for a slower-paced program, and the provision of duplicate personnel complements for launch preparations and associated efforts.

A minimum-cost program is one in which the amounts expended on operating burdens and time-saving factors are relatively in balance, and that is the case with our program as it was presented last year. The stretch out to the very last of this decade, which is the basis of the 1965 budget, involves some increase in costs over the level which could have been attained. But we have not planned, either for 1964 or 1965, premium overtime and inefficient multi-shift operations in order to save time. Neither, however, have we been forced to establish a pace so slow that the operating burden absorbs an exhorbitant share of the total expenditure.

If the lunar landing date is delayed further, the operating burden will begin to consume an unreasonable share of the funds provided. The costs to which I refer include the support of thousands of skilled engineers, scientists and technicians who must be on hand to support the flight and ground test activity that continues throughout the total development program, whether the ground tests are on three or six month centers. This includes the propulsion, electronics, structures, thermodynamics, astrodynamics, guidance, control and launch specialists and the supporting technicians, to name but a few, as well as the clerical and management staffs required by each industrial contractor to do business.

Let me repeat, this cost base exists whether we are flying once in three months or once in six months. As a result, the cost associated with each event in the program increases as the program is delayed. For this reason, if economy is to be the watchword, and if we are to meet the stated national goal of lunar exploration within this decade, both the supplemental appropriation and this authorization are required.

In considering the NASA authorization request in the past, this committee has expressed an interest in the requirement for scientists and engineers to carry out this work, and its impact on other areas of science and technology. I have testified previously that the evidence did not indicate that NASA's requirement was adversely affecting other areas, and in recent months there is mounting evidence which indicates the validity of that contention.

At the beginning of this calendar year, approximately 74,000 scientists and engineers were employed in the NASA program--about 12,000 within NASA, and 62,000 under NASA contracts and grants. This amounted to approximately 4.9 per cent of the 1.5 million scientists and engineers in the nation's work force.

By next January, it is estimated that about 82,000 scientists and engineers will be working on the NASA program; about 5.2 percent of the available national supply. If the space effort were to continue at the present level of funding for the remainder of the decade, NASA's program is not expected to require more than 5.5 percent of the national supply of scientists and engineers.

Of particular interest, however, is the fact that NASA's requirement for additional engineers has peaked at an earlier period than had been anticipated. Current statistics indicate that the number employed on NASA work increased by about 30,000 during the last calendar year, rather than 20,000 as had been anticipated. As a consequence, our requirement for the current year will be only about 8,000 instead of 18,000 as had been projected. We will thus require a much smaller share than had been anticipated of the 45,000 engineers who will complete their education this year.

It has also become increasingly apparent that NASA requirements have been met without significant adverse affects on the growth of the other programs requiring scientists and engineers. A substantial portion of last year's growth was absorbed by NASA contractors without adding new personnel, due to reductions in other programs, and upgrading of existing employees. NASA's industrial contractors are estimated to have absorbed last year at least one-fourth of NASA's increased scientific and engineering workload. Because of the relatively limited amount of new systems development included in the Defense budget for FY 1965, and other factors, this ability of industrial contractors to absorb additional NASA work without corresponding increases in their technical manpower requirements is expected to increase substantially.

I might also note that during recent weeks increasing public attention has been given to evidence that we may be moving into a period of surplus with respect to professional engineering personnel. The business newspapers and magazines have cited evidence from personnel agencies, and quoted surveys made by private firms, all of which point to a declining demand for engineering talent.

Only a few weeks ago, Dr. William J. Harris, Jr., Chairman of the Government Liaison Committee of the Engineers Joint Council, testified on this subject before the Select Committee on Government Research in the House. He stated the current situation about as clearly as any testimony I have seen, and with your permission, I would like to quote briefly from his remarks. He said:

"The impact of governmental research and development programs on the national posture has been of incalculable value. Those of use who have been fortunate enough to be involved in the great post-war research and development programs of the country have had the same sense of a great commitment to the national welfare that the entire population senses during a national emergency. We have seen our professional counterparts in other countries of the world under-used and somewhat despondent over their inability to serve their country at the full level of their competence and training. We have had the sense of participating in something not unlike a crusade in many of the great national research and development programs.

"We are entering a complex period of transition," Dr. Harris continued, "or appear to be on its threshold. Many statements have been issued by leaders of defense research and development management in the United States that we are near a plateau in weapons development.

"Were it not for the growing space program, the country could be in a period of declining utilization of scientists and engineers."

It would appear, Mr. Chairman, thatrather than using too much of the nation's technical manpower, space activity may well prove to be the force which holds together the nation's great resource of trained scientists and engineers. Only in one area, at the doctorate level, does there appear to be any continuing concern over the available supply. Some universities continue to report difficulty in maintaining doctorate-level teaching personnel.

Again, however, there is no evidence that NASA is contributing to this difficulty. A study of the 3,700 scientists and engineers recruited during the period July 1, 1961, through September 30, 1962, revealed that only 30 of those employed were teaching professors at universities immediately prior to their employment at NASA.

NASA has foreseen, however, that the imaginative, creative, highly-trained, scientist or engineer who has been trained to the doctorate level will always be in great demand. As a consequence, our pre-doctoral training grant program has been oriented toward insuring a continuing supply, and we are conducting a maximum amount of basic research under contract with the nation's universities, in order that it will contribute to graduate education, as well as produce the scientific results desired.

It may be of interest that these efforts are being carried out on a very broad basis throughout the nation, and are not concentrated in a handful of universities. Of the first ten pre-doctoral training grants made in FY 1962, only four went to schools in the so-called "big twenty" of the nation's universities. This year, 19 of the 20 are included--but there are training grants at 69 other schools which are not among the 20 leaders.

Through the use of project research grants, seed grants, and training grants, NASA is working with about 100 universities which are <u>not in the "big twenty</u>." We <u>are</u> broadening the basis of university participation in the space program.

May I also point out that while accomplishing the basic research which we require, and contributing to the production of highly trained scientists and engineers at the doctorate level, we are also seeking to employ our relationships with the universities to encourage the transfer of space research results to practical application by American industry.

In an era of diverse, complex and extensive research in every scientific and engineering discipline, the nation's institutions of higher learning have become virtually the only center in which the emerging mass of scientific and technical knowledge can be gathered, understood, and disseminated to those who will find it of value, and need to trust its source.

Within NASA, we have sought to encourage closer relationships between our university partners and the business, industry, and government leaders of the regions which they serve. It is our policy to place research contracts and grants at those universities where the scholars themselves, the consensus of the faculty, and the administration of the university are interested in having the work progress on a broad inter-disciplinary basis.

Further, in those instances in which grants are made for the construction of research facilities, the university must agree to undertake to create, in an energetic and organized manner, a broadly based multi-disciplinary team to explore means of feeding research results into the industries and segments of the economy with which the university has close relations.

In addition to these policies, the NASA technology utilization program is making progress in its efforts to insure that the benefits of space research are known and put to use. I will not go into this, since a special presentation is planned later in these hearings.

The year 1963 has seen a steady strengthening of understanding, coordination, and mutual support between the DOD and NASA. Mr. McNamara and I have worked closely together and the Aeronautics and Astronautics Coordination Board, as the principal medium of DOD-NASA interactions, has been re-vitalized. It has expanded its active monitorship to cover nearly every segment of the national space program. Under the aegis of this Board, we have jointly reviewed the requests for new facilities related to the aerospace R&D effort in the two agencies. This review has uncovered several instances where facilities would have resulted in duplication. Through corrective action in such cases, real economies have resulted. An important milepost was passed when, as insisted on by the Committees of Congress, the DOD and NASA jointly arrived at an arrangement for pooling the instrumentation ship resources required to meet the needs of both agencies. This also will save the government money.

A comprehensive joint review recently completed had the objectives of delineating the minimum space program to meet theneeds of the country and examining the programs of the two agencies for possible consolidations. The recommendations stemming from that review are now being acted upon.

Since the announcement by the Secretary of Defense of the decision to embark upon a manned orbital laboratory project, NASA has moved rapidly to gear its organization to assist the Air Force in every way possible in this undertaking. The Gemini-B/MOL program was needed by the DOD to make an early determination of the utility of a man in space in connection with certain potential defensive systems. The DOD will be able tomove ahead rapidly with plans to make this determination within the desired time frame by virtue of the fact that the necessary basic technology and capacity to provide the hardware and to conduct such an operation have been developed by NASA and are available, just as the availability of scientific knowledge and basic space technology enabled the Administration in 1961 to establish the manned lunar landing as a national goal to be achieved by the end of the present decade.

The DOD MOL program will be accomplished using many component systems and operational techniques which have been developed and proven by NASA. Necessary supporting facilities established by NASA will be made available and fully utilized. In providing this assistance, NASA will be fulfilling its proper role under theprovisions of the National Aeronautics and Space Act of 1958. At the same time, NASA will take full advantage of the opportunities presented by the MOL to further its research and development effort. Thus, the DOD and NASA will join forces to realize the maximum return from this expenditure of national resources.

During the course of this statement, Mr. Chairman, and members of the committee, I have endeavored to indicate that the program which is being proposed in the President's authorization request is one which will serve the nation's needs, and which will realize our national objectives in space at the minimum cost to the public.

In considering this request, it is important that it be viewed not only in terms of its direct benefits to the United States, but also as a force for progress in international cooperation during the years ahead. It has been noted that space is one of the few areas in which it has been possible for the East and West to find areas of common interest which can be cooperatively developed. The potential of these beginnings as the first step toward further cooperation in other fields, is not to be overlooked.

Dr. Hugh L. Dryden, the Deputy Administrator of NASA who is well known to you for his wisdom, and his long experience in governmental research and development efforts, is here today. He will elaborate on the international aspects of the United States space program in greater detail, and discuss the future potential of space research and development from a perspective which has deep and firm roots in the past. He will be followed by Dr. Seamans, who as general manager will get into more detail with respect to the proposed NASA operations, and also will discuss some of the management aspects of the program in which I am sure the committee has a great interest.

That completes my statement. I thank you again for the opportunity to be here.